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Joint Mi-24, Su-25 Tactical Exercises Resolve Training Problems

94UM0094A Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 5, May 93 (signed to press 6 Apr 93) pp 8-9

[Article by Lieutenant-Colonel Ye. Popov under the rubric "For High Combat Readiness": "Joint Strike"]

[Text] The economic crisis in our society cannot help but be reflected in the everyday activities of the army. We will be honest—the state of affairs in the ranks frequently reaches catastrophic in virtually all regions. The unsatisfactory logistical support is having a marked effect on the course of combat training for the air units in the Far East Military District as well, and naturally not in a positive sense. Many of the aviation commanders in the local areas thus have to rack their brains searching for ways out of the situation. They do find them, you know. By way of example, flight shifts have begun to be planned with the finely tuned orientation of each flight toward the comprehensive resolution of basic tasks of combat training, so as not to permit any further reductions in the professional qualifications of the pilots. The efficient use of simulators in particular is contributing to the cause of conserving material resources. People, that is to say, are not sitting with their arms folded waiting for suggestions from above, but are rather seeking out reserves themselves. But they understand that the maintenance of skills in the techniques of piloting alone is clearly insufficient to improve tactical flight proficiency—the principal aim of the martial labors of the aerial warriors.

This circumstance has obviously also prompted the officers of the detached air-assault air regiment to try and find non-standard solutions for these problems. There have been lots of proposals, but the most realizable—and ingeniously simple—one came from Deputy Commander Military Pilot 1st Class Lieutenant-Colonel V. Yeshmyakov.

Its essence consists of the following: to perform the tasks of tactical flight exercises [LTU] in conjunction with our neighbors, helicopter pilots, taking into account experience in the interaction of Su-25 aircraft and rotary-winged craft during the combat operations in Afghanistan. Valeriy's idea was then supported by everyone. The first results of the flights organized in the new fashion have confirmed its vitality. The LTU I wish to talk about became the logical continuation.

No, we were not able to accomplish everything planned right away. The fact is that, as with everything new, Yeshmyakov's idea required a considered approach and precise calculations in order to see that the undertaking itself was not discredited, and to prove its right to life. The first difficulties arose as early as in the stage of preparing for the LTU. That is understandable—there was nowhere to turn for experience or official documents for performing such exercises. The flight-control officers of the helicopter and attack-aircraft air regiments had to be trailblazers here. And they managed to do so, efficiently putting forth methodological recommendations, elaborations of variations for joint actions and calculations for the efficient application of forces. This was facilitated by the fact that many of them had completed the harsh schooling of Afghanistan.

What did they use as the basis of the calculations? First and foremost, the conclusions of military scholars, both domestic and foreign, seeking to prove the effectiveness of close interaction among diverse aviation forces. The capabilities of the Mi-24 crews to detect, identify and destroy armored targets on the battlefield, by way of comparison, are several times greater than the analogous ones for the Su-25 crews. The latter, however, are able to overcome the resistance of enemy PVO [air defenses] more successfully. It is thus not surprising that the results of modeling their joints operations showed that they are 1.6—2.1 times more effective than autonomous operations, while the losses of the one and the other were reduced by 30—50 percent. The required helicopter and attack-aircraft forces were 20—30 percent lower in that case accordingly.

These data were also used to develop the plans for the impending exercises, namely the distribution of forces for the accomplishment of combat-training tasks. Comprehensive group exercises on LTU topics were devoted to clarifying them. All of the training had to be conducted on the ground, using simulator systems to the fullest extent, for understandable reasons. The pilots of both regiments realized very well how difficult the tasks facing them would be to accomplish, and were thus thoroughly prepared.

The IAS [aviation engineering service] specialists had their own concerns. Each technician experienced for himself that the less his aircraft flies, the greater the attention that must be devoted to it in servicing. The personnel, for all that, prepared the aircraft for the exercises very well. The standouts included aviation technical detachment commander Major G. Makukh, armaments engineer Captain V. Golub and servicing group chief Captain A. Nefedov.

Proper credit must also be given here to the specialists of the support services—Senior Sergeant A. Gusarov and Sergeants Ye. Stetsyuk and I. Khalilov, among others. The military collective of the air garrison, that is, was working at a uniform rhythm, united for a common aim—to achieve success.

The first to go up were helicopter pilots of the group commanded by Major N. Vasilyev. Understanding very well that the operations of the rest depended on the results of their work, each of the reconnaissance crews was in a combat frame of mind. Reaching the assigned area in concealed fashion, they carried out the search, transmitted the coordinates of targets detected, and identified and even designated the targets in the next pass.

The attack aircraft appeared behind them on the practice range. Leader Major A. Sirotin did not miss the opportunity to confirm his reputation as a leader; making use of all of the might of his on-board weaponry, he suppressed the fire of the "enemy" air defenses on the move. The wingmen supported the initiatives of the squadron commanders. A group of Mi-24 helicopters rushed into the "overflight corridor" that had been formed. Could the helicopter pilots really let down their commander, Major A. Sobolev, with the LTU were being held on the eve of his birthday?! They deluged the tank targets with a sea of fire and smoke from the rockets on the first pass.

Then the attack aircraft were back in the sky. While excellent work on the practice range was the rule for Major S. Salnikov, Captains Yu. Zabudko and S. Esse—who had recently obtained their 1st class ratings—were pretty anxious before the sortie. But for no reason at all, judging by the results. Participation in the ground attack was for them yet another opportunity to verify for themselves their mastery under conditions that were as close to combat conditions as possible.

It is in just such a climate that you understand that common victory in a military action takes shape from the individual achievements of each soldier. That is how the successes of Captain I. Abdullayev's flight can be explained—there were two destroyed "enemy" artillery emplacements on the scorecard of his pilots in one pass. Such is the style of the new masters of weapons delivery. They were entrusted with putting the period to the end of the LTU. And they did not disappoint.

The tactical flight exercises are behind us now. I would say right off, first of all, that the work of the fliers on the practice range was assessed as excellent by the evaluators, and their smooth interaction in the air was noted in particular. The joint strike justified itself in every way—virtually all of the targets were destroyed, the evaluation of the system of command and control of the crews in the air was conducted successfully, and a high level of organization of aerial reconnaissance and search-and-rescue support was achieved. The hypothetical losses of the crews proved to be minimal as well. Second, a considerable economy of fuel and ammunition was also achieved in the LTU through the joint performance of analogous tasks using a reduced complement (on both sides).

But the aviators have not forgotten the results, and they have drawn conclusions and lessons for tomorrow. It also makes sense for others to think some about what can be undertaken—even on the scale of a single regiment—if one does not wait for something to turn up, and works creatively instead. And all that is because—and this is third—the people, yearning for the true business, finally found faith in themselves and felt the taste of victory. That is the moral achievement of a cohesive collective—the gaining of hope.

When this material had already been prepared for publication, I called Khabarovsk. It became clear from my conversation with a senior air officer that the policy of developing command independence, creativity in the accomplishment of combat-training tasks and the rejection of stereotypes among the attack-aircraft and helicopter pilots at garrison X was unchanged.

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Afterburner Ignition Failure Common Cause of Takeoff Accidents

94UM0094B Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 5, May 93 (signed to press 6 Apr 93) p 10

[Article by Colonel Yu. Timchenko, deputy chief of the LP [Flight Accidents] Investigation Directorate of the RF Armed Forces SBP [Flight Safety Service], under the rubric "Flight Safety: Special Situation": "Thirty Seconds in a Takeoff..."]

[Text] *Many years of accident statistics demonstrate that the takeoff is one of the most unsafe stages of a flight. Gross errors in piloting and failures in aircraft hardware during it lead, as a rule, to grave flight accidents with the death of people.*

The weather that day, as they say, was gorgeous. The crew of an Su-24—Senior Lieutenants I. Chizhenko and S. Dzhololov—were preparing to make a performance-graded flight as part of a pair.

Forty seconds after takeoff of the lead aircraft, the pilot brought the engine RPM to maximum, set the RUDs [engine control levers] to "Full Afterburner" and released the brake. A turning moment arose in the direction of the left engine during the takeoff run, which the pilot attempted to counter by deflecting the right pedal and using the brakes. He accomplished separation of the nose wheel at a speed of 180 km/hr. The angle of attack reached 15° therein (instead of the recommended 10—12°), while the deviation of the aircraft from the takeoff heading was 3° to the left.

The attempt of Chizhenko to kept the aircraft on the runway by deflecting the pedal and the stick by ⅔ of their full range was not successful. The deviation from the takeoff heading reached 13° before the separation of the aircraft, and the threat arose of its running off the runway. The pilot, seeing the inevitability of continuing the further run off of the artificial surface, set the pedal in a position that was close to neutral.

In the 20th second of the flight, after crossing the side safety strip, the aircraft separated at a speed of 290 km/hr with a left bank and angle of attack of 20.3°. A second later the flight control officer and his assistant gave the command to the pilot to reduce the climb angle. As a consequence of the Su-24 entering a mode of neutral G-forces, the presence of slip, a sharp reduction in the effectiveness of the controls and the inaction of the pilot, there occurred a further increase in the angle of attack (more than 33°) and left roll at an angular velocity of 10°/second.

The flight operations officer [RP] twice gave the command to the crew to eject in the 25th second of the flight of the aircraft, at an altitude of 15 meters and a roll of 50°. The aircraft hit the ground a distance of 400 meters from the runway axis in the 30th second with a left roll of 90°, and the crew was killed...

What dangerous factors led to the appearance and development of this catastrophic situation?

The complication of the flight conditions occurred owing to the failure of the left engine afterburner to ignite, caused by a failure of the spark gap and gas rectifier of the ignition system. The crew, in order to keep the situation from disintegrating into an emergency, should have performed functional duties to monitor the operating mode of the power plant before the takeoff—and in this case turn off the afterburner mode of both engines, report the curtailment of takeoff to the RP and taxi to the hardstand.

Unfortunately, neither the pilot nor the navigator seems to have followed these rudimentary recommendations. The takeoff was continued, and the dangerous factor was not localized.

The pilot could have averted the disintegration of the situation into an emergency by fulfilling one of the following alternative conditions:

—the making of a timely decision to curtail the takeoff (there were four seconds of time reserve to assess the situation and make a decision, with the length of the takeoff run not exceeding 630 meters);

—the continuation of the takeoff with the maximum use of the controls to keep the aircraft on the runway, and error-free piloting with regard to the angle of attack.

The difference in thrust between the two engines when the afterburner on one of them was not operating was 4,700 kgf. Calculations and the results of flight testing have shown that it can be countered by the maximum deflection of the rudder. The reserve of flight mass at which gain in altitude in possible with one engine operating in full afterburner mode was 8,000 kg under the actual conditions of this takeoff.

There was also no help for the crew, when the deviations, arose on the part of the GRP [flight operations command and control group] specialists, since their capabilities for the continuous monitoring of the aircraft in the takeoff run are extremely limited owing to the positioning of the workstations at the command and control post; the command to reduce the angle of attack in takeoff was issued too late.

The emergency situation ensued at the moment of separation of the aircraft and its reaching of supercritical angles of attack, when it was now no longer possible to avert stalling by vigorous pushing of the stick. The sole correct decision of the crew under these conditions would have been to abandon the aircraft immediately.

The safe ejection zone, calculations have shown, was at the interval of 12—22 seconds. The emergency ejection gear could not save the crew starting at second 23—at a roll of 35° or more and a speed of 300 km/hour, the parachutes would have opened only at an altitude of 15 meters, which would not make it possible to lessen the speed of the "man—parachute" system to a speed that would be safe for survival. The crew's decision to eject was eight seconds late.

Statistics show that the reliability of engines in afterburner ignition is not adequate. There have been eleven such instances recorded in units where this flight accident has occurred over the last three years alone.

The unreliability of the pilot, which depends on more than his level of training alone, is the chief danger factor under conditions of a sharp reduction in flying time. A knowledge of the aerodynamic properties of the hardware being operated, a well thought-out and effective system of conducting training sessions with the practicing of skills for averting special cases in flight and, finally, personal monitoring both on the ground and in the air—these are the conditions for ensuring the personal safety of the pilot.

The short duration of the takeoff of a modern aircraft does not leave time for the assessment of the situation and the making of decisions; it requires immediate and competent actions. Therefore, increase attention toward the takeoff!

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Improved Organization of Military-Historical Teaching Proposed

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[Article by Candidate of Historical Sciences and Docent Colonel (Reserve) N. Zavgoroniy under the rubric "Military Reform and Higher Educational Institutions": "See the Future by Comprehending the Past"]

[Text] The reform of higher military schooling urgently requires a reconsideration of the attitude toward military-historical training (VIP) of cadets and enrolled personnel at Air Forces higher educational institutions. Its content and volume today do not fully conform to national and international norms; whence the low level of military-historical knowledge of matriculants at the academies, and the absence of any logical link between the academic teaching discipline of "The History of the Military Arts" and the curriculum of the schools in "Military History"; there is no center that would coordinate military-historical training in the Air Forces. The importance of VIP for the military cadres, and the consequences of underestimating the formation of a historical consciousness of the Air Forces among them, have unfortunately not yet been realized.

Moreover, the role of VIP for cadets and enrolled personnel in the system of higher military education is increasing. The military-historical disciplines, after all, are an important component of the operational-tactical, special and humanitarian training of military cadres. The creative assimilation of contemporary military arts is possible only based on the clarification of military-historical experience and its lessons and an understanding of overall principles and general laws, which not only stimulates professional training but also serves as the basis for the patriotic and moral indoctrination of officers and facilitates the formation of leadership qualities.

A natural question is, what must be done to bring the level of VIP at Air Forces higher educational institutions into conformity with the requirements of the times, with the nature, specific features and development prospects of the armed forces of the Russian Federation?

I will try to answer.

There are no doctors today among the cadre officers who are instructors in the military-historical disciplines at the Air Forces academies, and no candidates of historical sciences at the military schools. The training and retraining of cadres in the field of "Military History" must thus be improved first of all. Young and promising instructors who are candidates of historical sciences could be thus recommended for doctoral studies, and those who have no academic degree, especially at the schools, could enter graduate studies in the department of the history of the military arts of the VVAs [military aviation academies] for this purpose. It would be expedient to train military-history instructors for the academies, as well as to retrain them, based on the Military Academy of the General Staff.

The problem of the scarcity of historians at the Air Forces schools could be resolved first through training at the Retraining and Skills Enhancement Department of the Air Forces Academy imeni Yu.A. Gagarin. Their subsequent training is most expediently continued according to individual plans in the departments of tactics of the military aviation schools.

The future creation of a teaching group on the basis of the academy, oriented toward the training of military historians for the higher educational institutions, NIU, Air Forces Main Staff, newspapers and magazines would seem to make sense in the future. Young officers interested in military history from the ranks, as well as the enrolled personnel of the academy who recommend themselves through their participation in the work of the VNO [military-science society] circle in the department of the history of the military arts, could be brought in for training.

The name, purposes and content of the military-historical discipline being studied at the Air Forces schools of the RF must be clarified. It is called "Military History" today. Yesterday's grade-school pupils, however, are scarcely able to study "The History of Warfare," "History of the Development of Armed Forces," "History of the Military Arts," "Military Historiography" and the other courses of study that constitute this concept over 120 hours. It is obviously worth discussing the "History of Warfare"; a cadet, having studied it, should know the aims, nature, essence, experience in preparation and waging of the most important wars since ancient times up to the present day, the reasons for triumphs and defeats in them and the effects of wars on the development of Air Forces tactics. Anyone who has studied the "History of Warfare" should be able to make creative use of the knowledge he has obtained in his studies at the school and during service in the ranks.

The course "The History of the Military Arts" at the Air Forces academies will become the next, higher degree of acquisition of military-historical knowledge. Enrolled personnel should know, as a result of it, the history of the operational arts of the Air Forces and the ground forces since the time of their birth up to the present day, the fundamentals of the history of the operational arts of PVO [air defense] and naval forces, and the general laws, principles and lessons that arise from the experience of the development of the operational arts. The nature of the military-educational institution and the actual capabilities of the department or training cycle must naturally be taken into account when determining the dedicated purpose and content of the courses.

Four sections can be introduced into the course of "The History of the Military Arts," proceeding from the dedicated principle. The first considers the birth of the military arts in Russia and their development before World War I; the second, the development of the military arts during World War I, the civil war and the period between the wars; the third, World War II; and, the fourth, after World War II. The course could conclude with the study of the topics "The Lessons Arising Out of the Experience of the Development of the Military Arts" and the "Tasks of the Commander (Commanding Officer) in Supervising Military-Historical Work Among the Troops," with the subsequent passing of an examination.

The assimilation of the military-historical disciplines should precede, in the structural-logical system of training cadets and enrolled personnel, the study of the tactical disciplines at the schools and operational-tactical ones at the academies. Things are unfortunately still the reverse at the Air Forces Academy imeni Yu.A. Gagarin.

There is another substantive issue as well. The study of "Patriotic History" and "The History of the Military Arts" at the academies is now conducted in different departments, and there is no logical connection or succession between the disciplines. It would seem expedient to study the historical disciplines at the Air Forces higher educational institutions in a unified department of "The History of the Fatherland and the Military Arts," and in

the departments and cycles of study of tactics at the Air Forces military schools. That is indeed what was done in prerevolutionary Russian military schooling, and is currently done at the higher educational institutions of the distant abroad. The Air Force Academy in the United States, for example, studies modern military history (120 hours) in the first year, the modern history of warfare and society (120 hours) in the second, and military theories and an analysis of the state of armed forces (120 hours) in the fourth year.

The activity of military historians is in need of academic guidance on the scale of the Air Forces of the RF. This function could be entrusted to the Historical Group of the TsOTI of the Air Forces Main Staff or to a specially created academic-instructional council on a voluntary basis. It would formulate a strategy for military-historical work in the Air Forces, long-term plans for the publication of the necessary literature etc.

The publication of an official document (order, directive) with an analysis of the state and tasks of military-historical work in the Air Forces also seems expedient during the preparations for the 80th anniversary of the military aviation of Russia (1994) and the 50th anniversary of Victory in the Great Patriotic War (1995).

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Mathematical Modeling Assists Investigations of Flight Accidents

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[Article by Doctor of Technical Sciences Colonel A. Volodko, honored figure of science and engineering of the Russian Federation and State Prize laureate, under the rubric "Flight Safety: Investigating Flight Accidents": "Modeling Gives the Answers"]

[Text] *Methods of mathematical modeling associated with the use of high-speed computers are becoming more and more widespread in the investigation of flight accidents [LPs], dangerous failures of aircraft hardware and errors by the flight personnel. The urgency of their use could seem, at first glance, not very great for modern aircraft equipped with Tester or MSRP-64 type flight data recording gear (BUR).*

The informativeness of specific types of BUR naturally differs, but it provides a sufficiently complete representation of the nature of the development and, in the aggregate with a host of one-time commands, on the possible cause for the appearance of an emergency situation in flight. The parameters recorded, at the same time, frequently prove to be insufficient to establish the true cause of an LP. In order to make a judgment regarding the pattern of the airflow around an airframe, for example, it is essential to know the angles of attack and slip, which are not on the recording list. Most importantly, not one kind of BUR can determine the trajectory of aircraft movement, and it is the last leg of a flight (before an aircraft hits the ground), after all, that is of the greatest practical interest in the investigation of a flight accident.

The MSRP-12-93 magnetic flight recording system, installed on the An-12, An-26, Tu-95 and Tu-22 aircraft and Mi-6 helicopter in particular, records only 12 analog parameters of a flight, including the barometric pressure and indicated airspeed, vertical G-forces, angles of deflection of the controls, angles or angular velocities of pitch and roll and two or three diagnostic parameters of the operation of the power plant. The SARPP-12 optical recording system employed on the MiG-23 aircraft and Mi-8 and Mi-24 helicopters puts only six analog parameters onto photographic film. They are insufficient, in both cases, for an analysis of the development of an emergency situation and the establishment of the causes for an LP.

It also happens that the information medium is destroyed, lost or stolen. A representation of the trajectory and nature of the movement of an aircraft on the last leg of its flight is formulated in such cases according to indirect indications (sketch maps, ground objects destroyed, the results of study of the aircraft hardware, the indications of witnesses and the like).

Mathematical modeling of the dynamics of a flight thus proves to be useful and necessary, both with the availability of information from flight data recording systems and, the more so, in the absence of it for any reason. When investigating a flight accident it allows, by way of example, computation of the parameters of aircraft movement according to a known initial flight mode and assumed destabilizing factors.

The legitimacy of versions that are put forth with reference to the circumstances of the flight accident is analyzed, in that case, according to the results of mathematical modeling of the dynamic reaction of the aircraft to the effects of disturbances caused by the failures of the aircraft hardware or erroneous controlling actions of the pilot that are being considered.

Tasks of the second type (the reciprocal task of flight dynamics) are also posed and resolved in those cases when, according to the objective data (information from the on-board recording devices, radar plotting of the flight route), the trajectory of movement and the angular position of the aircraft are known, with unknown destabilizing factors present. The forces and moments required for the parameters of such movement, as well as the necessary settings of the controls to create them, are determined according to the results of the mathematical modeling. This provides an opportunity, based on cause-and-effect links, to single out from among the aggregate of proposed versions only those that satisfy, or at least do not contradict, the actual parameters of the aircraft flight in the emergency situation.

An evaluation of the good working order of the aircraft hardware is accomplished only for an aircraft equipped

with the Tester or MSRP-64 systems. The flight mass (m), center of gravity of the aircraft, trim positions of the controls, stability reserves, moments of extension or retraction of the flaps or air brakes, changes in the sweep angle of the wings and some other important data can be singled out therein when investigating an LP.

The dynamic equations of Euler are the methodological foundation for modeling the dynamics of aircraft movement, with the aircraft in most cases considered to be an absolute solid body of constant mass (1):

$$m(V_x + \omega_y V_z - \omega_z V_y) = R_x,$$

$$m(V_y + \omega_z V_x - \omega_x V_z) = R_y,$$

$$m(V_z + \omega_x V_y - \omega_y V_x) = R_z,$$

$$I_x \omega_x + (I_z - I_y)\omega_y \omega_z - I_{xy}\omega_y = M_x,$$

$$I_y \omega_y + (I_x - I_z)\omega_x \omega_z - I_{xy}\omega_x = M_y,$$

$$I_z \omega_z + (I_y - I_x)\omega_x \omega_y + I_{xy}(\omega_y^2 - \omega_x^2) = M_z,$$

where V_x, V_y, V_z, ω_x, ω_y and ω_z are projections of the linear and angular velocity of the aircraft on the right body axis of the system of coordinates; R_x, R_y, R_z, M_x, M_y and M_z are projections on the same coordinates of the resultant forces and moments acting on the aircraft; and, I_x, I_y, I_z and I_{xy} are the moments of inertia of the aircraft with regard to the corresponding axes of the coordinates.

For a helicopter, the system of equations (1) is usually supplemented with an equation of the dynamic of rotation of the main rotor:

$$I_r \omega = M_{eng} - M_t,$$

where ω is the angular velocity of the rotation of the main rotor; M_{eng} is the available rotating moment of the engines; M_t is the required torque of the main and tail rotors; and, I_r is the polar moment of inertia of the main rotor and the assemblies kinematically linked with it.

The angular velocities of pitch ω_z, roll ω_x and yaw ω_y are determined as a result of integrating the equations for the dynamic of aircraft rotations with regard to the center of mass, and are used to compute the corresponding angles ν, γ, and ψ.

The trajectory of movement in the system of ground coordinates is determined according to the components of the forward speed of flight V_x, V_y, and V_z and the angles ν, γ, and ψ.

The forces R_x, R_y and R_z and the moments M_x, M_y and M_z acting on the aircraft and determining the right portions of the system of equations (1) are quite complex, non-linear functions of the design parameters of the aircraft and the kinematic parameters of its flight (the speed and barometric altitude, angles of attack and slip, angular velocities of pitch, roll and yaw, positions of the controls). These forces and moments are determined by the aerodynamic design of the aircraft, and are entered into the computer using interpolation tables, polynomials or rough approximation formulas.

The law of automatic control of aircraft flight is usually realized in the form

$$T_{\varphi\Delta\varphi+\Delta\varphi} = K_1 \Delta q + K_2 \Delta q_i,$$

where D_φ is the settings of the controls (elevator, stabilizer, ailerons, cyclic pitch control and the like); Δq_i is the change in the kinematic parameters being controlled or stabilized (angle of pitch or roll, heading, speed and altitude of the flight) from the set trim position; and $T_\varphi K_i$ is a constant for time and the gear ratio of the SAU [automatic control system] (autopilot).

The modeling of the operation of the power plant plays an important role in investigating an LP, the more so as it is namely its failure in flight that is the cause of most emergency situations and accidents. The mathematical model of the power plant, in its most general and simplified form, includes the known operational characteristics of the engines (throttle, altitude and speed, climatic), an equation for the dynamics of the turbocompressor rotor

$$T_n \Delta n_{tc} + \Delta n_{tc} = K_G \Delta G_T,$$

and the law of engine control

$$T_G \Delta G_T + \Delta G_T = K_\alpha \Delta \alpha_{ec},$$

as well as the laws for the automatic regulation and limitation of the defining parameters of the engines.

Here Δn_{TK} and ΔG_T are the changes in the rotational frequency of the turbocompressor rotor and the hourly consumption of fuel compared to their established values in the initial flight mode of the aircraft; $\Delta \alpha_{ec}$ is the setting of the engine control level from the set trim position; and, T_G and K_G are a time constant and a transfer factor defining the characteristics of the engine (time of pickup and throttling).

The mathematical model for the dynamic of the flight defines the unstable three-dimensional controlled movement of the aircraft in special situations, caused by the failure of the aircraft hardware, erroneous control actions by the pilot or intensive external influences. The modeling of disturbing factors is usually accomplished in the form of various time functions with varying parameters, approximately describing objective data on the circumstances of the flight accident and (or) put forward in the course of investigating a version as the possible cause of an accident.

One may cite as examples of the modeling of typical disturbing factors:

—the complete, unexpected failure of one of the two engines, accompanied by a reduction in its thrust or power according to a law close to exponential;

—the mechanical jamming of a control channel;

—the break-off of a piece of the main rotor, accompanied by the effect of cyclical unbalanced centrifugal force $\Delta N \sin \omega t$;

—the effects on the aircraft of a vertical ascending gust of wind with a velocity W and gradient section of velocity build-up τ.

The disturbing factors are naturally individual in each specific case in the investigation of a flight accident, but their modeling requires a certain experience and skill of the researcher.

Mathematical modeling is successfully employed, aside from the global task of flight dynamics considered, to resolve a broad circle of partial but in practice exceedingly important tasks, among which could be included:

—the ballistic computation of the trajectory of destroyed elements of an aircraft that have separated in flight (stabilizer surfaces, parts of a propeller blade, cockpit canopy and the like);

—modeling of the non-standard interaction of the SAU with elements of the piloting and navigational system;

—computation of the intensive flywheel movement of an elastic main rotor blade accompanying a blow by the end of the blade against the tail boom of the helicopter in a single-rotor configuration;

—modeling of the overturning of a helicopter in a non-design-rated turn in taxiing etc.

Improvements in the mathematical models, for the realization of which personal computers are beginning to be utilized successfully, including those using leads coming from on-board flight data recording gear, are constantly underway.

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Summer Conditions Pose Particular Aircraft Servicing Problems

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[Article by Candidate of Technical Sciences Colonel (Reserve) K. Suponko under the rubric "Advice for IAS Specialists": "They Have Their Own Concerns in Summer"]

[Text] The servicing of aviation hardware in the summertime has a number of specific features, knowledge of which will help personnel to avert breakdowns in flight in a timely manner.

One of the most typical causes of failures is the refueling of an aircraft or helicopter using substandard fuel that contains water. This is usually a consequence of the violation of regulations for its storage in fuel dumps, and a lack of airtight seals on service and holding tanks and airfield fuel lines. The development and testing of the IVT-1 instrument to monitor fuel for the presence of water has currently been completed, and a small lot of them has arrived in VTA [military-transport aviation] units. It would be expedient to employ potassium permanganate in places that do not yet have those instruments; it provides an easily noticeable reaction with water.

Rain can bring quite a bit of unpleasantness. The pipes of the central aircraft refueling system were underwater at one airfield after a downpour. The water got into the pipeline through a bad seal and later, with inadequate monitoring of the fuel, into the tanks of aircraft, which led to the failure of several engines in flight. It should be noted that draining the residue from aircraft tanks does not always make it possible to detect substandard fuel in a timely manner; this is because there are areas in the lower portion of the fuel tanks of some types of aircraft that are not in communication with the drain points. They can be formed either by the folds of soft fuel tanks, or by longitudinal and transverse metallic partitions. The undrained fuel residue sometimes reaches several dozen liters. It is thus essential, when instances of the refueling of aircraft with substandard fuel have been ascertained, not only to drain it by the usual methods, but also to extract the residue from the undrained areas.

The consequences of operating engines using fuel with water are the extinguishing of the flame in the combustion chamber, disruption of fuel feed owing to clogging of the fine filters with water, and corrosion damage to parts of the fuel-regulating apparatus, leading to its jamming or sticking. The decision on the procedure for the further servicing of an aircraft after refueling with substandard fuel is made after an engineering analysis of its technical condition, with a regard for the requirements of servicing documentation.

The contamination of GSM [fuels and lubricants] in the summer is also possible when dust gets into them. The use of a closed refueling system under pressure is thus recommended, under conditions of enhanced dust, for those aircraft whose design provides for it, with measures to protect against dust penetration observed for open refueling. When systems are unsealed (for the replacement of fuel, oil and hydraulic filters, for example), steps that rule out the entry of mechanical impurities into them must also be envisaged.

The state of the filter elements is objective evidence of the cleanliness of the operating fluids. The level of their dirtiness is determined by their flow duration using a PKF (filter element monitoring instrument)—the greater the duration, the dirtier the filter element. This check is performed during routine operations before the ultrasound cleaning of the filter elements, as well as after it. If they turn out to be very dirty, it is essential to determine the causes for that in order to endure the failure-free operation of the aircraft in flight.

If a lack of airtightness is detected in the systems, the possible appearance of the physical phenomenon of

obliteration should be taken into account. It essence is as follows—a leak through a slot of micron dimensions, starting quite intensively, decreases appreciably over a certain time, and in some cases even ceases. This occurs as a result of the mechanical contamination of the narrow channels with insoluble particles, as well as the formation of a special aggregate state of the liquid molecules on the walls of the channels that creates boundary layers with a certain strength. Obliteration accelerates with an increase in the consumption of the operating liquids through the slot and with increases in temperature, which is typical of summertime conditions. One must thus not be limited to wiping and the tightening of joints, even if there is no seepage detected after that for a certain period of time; it is essential to make sure that the obliteration of a crack has not been "hidden," and whose further development could have dangerous consequences. If it is detected, the damaged parts must simply be replaced and the conditions and reasons for the appearance of the crack established, in order to make sure that it is not the manifestation of some other flaw such as an increased level of vibrations.

The most dangerous consequence of a lack of airtight seals in the fuel, oil and hydraulic systems is the outbreak of a fire. Operating fluids are ignited when they come into contact with hot sections of aircraft or engine systems, as well as damaged sections of electrical wiring. The most easily combustible ones, even in the absence of open flame, are the hydraulic liquids and lubricating oils. This danger increases during summer servicing periods, since the temperatures of structural elements of the aircraft increase through external heating.

Turbojet engines [TRD] are easily started under conditions of increased temperatures of the surrounding air. The start-up of a TRD that has not had time to cool down after shutoff, however, has certain specific features. There is an engine speed holdup with the throwing of the gas temperature behind the turbine in start-up, owing to the fact that the air in the air-intake channel and in the engines is heated. Such failures used to be of a mass nature with start-ups of hot AL-21F-3 type engines. Recommendations were thus entered into the servicing manuals, after special research that determined that the RUD [engine controls] should be moved to "idle" 30—35 seconds after pushing the "start" button when starting up an engine that had not had time to cool down. The cranking of the turbine to remove the heated air from the air-gas duct and subsequent start-up were thereby combined into one cycle.

Aircraft and helicopters should be positioned in such a way that their air intakes are pointed into the direction of the wind, especially when they are high in velocity, for the more reliable start-up of gas-turbine engines of all types. This improves the cooling of the engines, and reduces the required capacity of the electric-power sources by easing the cranking of the rotors.

Attention should also be paid to the fact that the parameters for the start-up and idle mode also carry valuable diagnostic information on the technical condition of the engine. There have been many cases where the flight, engineering and technical personnel have been able to ascertain dangerous failures of the automatic fuel apparatus by increasing the duration of the start-up cycle according to the value of the maximum gas temperature behind the turbine. The idle mode is the first operating mode of the power plant that establishes an equilibrium, which is maintained by a minimal consumption of fuel. The engine is thus more sensitive to changes in the state of the elements in its flow portions. It is possible to ascertain in a timely fashion, by monitoring the rate to reach revolutions and temperatures in idle mode, such problems as damage and destruction of compressor and turbine blades, cracks in the combustion chamber, and the destruction of fuel feed lines to the nozzles of the main combustion chamber.

The likelihood of deviations in the structural elements of the aircraft from increased discharges of static electricity increases appreciably in the summer, creating the danger of a discharge during fueling and a subsequent fire. The reliable grounding of both the aircraft and the refueling equipment is therefore essential, especially after the return of aircraft and helicopters from dense clouds and areas of thunderstorm activity.

The specific features of servicing runway equipment during the summer include regular monitoring of the air in pneumatic tires. The point is that when the temperature of the surrounding air increases by 15°C, the pressure in the tires increases by 10—12 percent, leading to increased likelihood of their rupture in sharp braking.

Summer also requires increased attention toward ensuring the protection of engines against the entry of dust and small foreign particles from the surfaces of the airfield. Erosive wear and damage to parts of the air-gas duct by foreign particles leads to a reduction in the reserves of gas-dynamic stability and the formation of nicks—concentrations of stresses that are often the centers for the formation of fatigue cracks. Constant monitoring should thus be performed—both when preparing for flights and when making them—of the cleanliness of the areas where the engines are started and tested, as well as the taxiways and runways. The likelihood of the entry of foreign objects into the air intakes is increased when the rules for aircraft taxiing are violated (high speed, high engine RPMs) and when the moving row of aircraft is blown by gas streams.

The trajectory of the movement of particles in the operation of helicopter power plants has its own specific features. The dust raised by the inductive flow of the main rotor moves to the periphery of the area swept by the main rotor, is sucked up into the zone of rarefaction under it, and then is thrown back down by the inductive flow. A considerable portion of that dust is in the rarefaction zone created by the engines and is sucked into the air intakes. It must be noted that helicopters with gas-turbine engines, as opposed to aircraft, do not create vortex or turbulent flows that throw the dust right from the ground into the air intakes. Special dust-protection devices are employed as design features on helicopters. The cleanliness of the separators must be

checked on aircraft fitted with them during flight preparations. Their fouling leads to a reduction in the effectiveness of the dust-protection devices, and to an increase in the non-productive expenditures of engine capacity.

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Poll of Academy Graduates Details Bleak Outlook for Future Service

94UM0094F Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 5, May 93 (signed to press 6 Apr 93) pp 28-29

[Article by Major B. Afanasyev under the rubric "Topical Theme": "Would Be Glad To Serve..."]

[Text] The experience of domestic and foreign military reforms shows that when they are implemented, the central issue was and remains the professional training of military cadres. The current military reform, in the course of which the foundations are being laid and the prospects defined for the development of the new Russian armed forces, is no exception. A study of the readiness of officers who are graduates of military academies for professional activity is of particular interest in this regard. This interest is explained by the fact that tomorrow, serving in official positions, they will largely determine the state of the army, its image and the level of training.

The changes in all spheres of the life of society are having an objective influence on the consciousness of citizens, including officers. The nature and results of this influence were of interest to a group of research sociologists of the Academy of Humanities, who conducted a poll of the enrolled personnel in the final-year courses at the VVA [Military Aviation Academy] imeni Yu.A. Gagarin and the VVIA [Military Aviation Engineering Academy] imeni N.Ye. Zhukovskiy in 1992. Some 211 people were selected under a quantitively regulated sample to provide sufficient representativeness.

The results of the poll established that most of the respondents were guided in the choice of the profession of officer first and foremost by socially significant motives (Fig. 1). Some 81.8 percent of those polled, in evaluating the usefulness of the labor of an officer compared with other types of activity, noted its high or very high significance. These data provide grounds to suppose that the greater portion of the respondents were guided in their choice of profession by moral incentives, and the prestige of the profession of officer in society played a substantial role in the formation of the professional-military thrust of their choice.

Most of the graduates have a high regard for their labor as before. The difficult processes in the life of society, however, are more and more adjusting the social portrait of the graduate of the military academy. Significant changes in the system of value orientations are being observed in the environment of the servicemen as well. These polls show that more than half of the officer graduates today place tranquil service conditions, low tension, high earnings and sufficient time for relaxation in first place when evaluating their service activity (Fig.

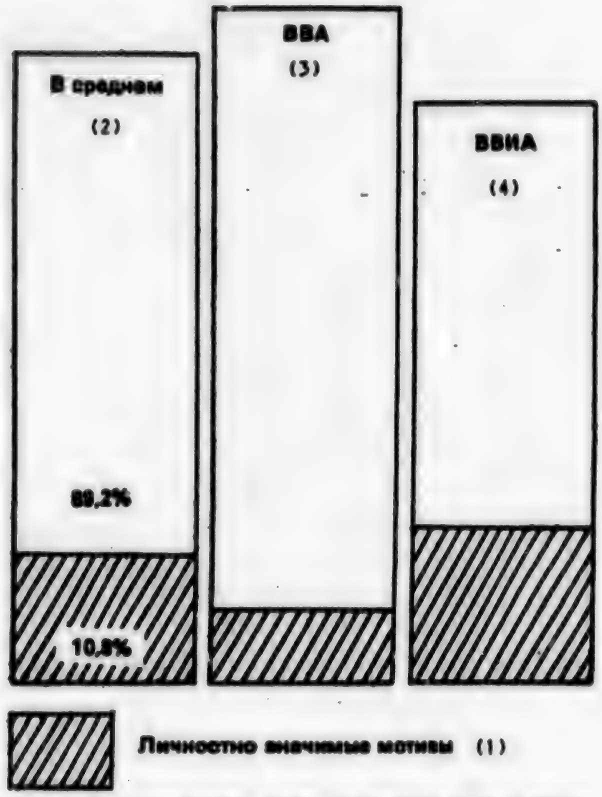

Fig. 1. Reasons for the choice of the profession of officer

Key:
1. personally significant motives
2. average
3. VVA
4. VVIA

2). A tendency for the displacement of values orientations from socially to personally significant is clearly pronounced. It became clearly in the polling that most of the respondents consider the receipt of high earnings to be the most important thing for themselves. The officer—the representative and expressor of state and social interests—thus has personal rather than social values in the forefront.

The process of further cutbacks in the size of the army and the uncertainty of the future is having a negative effect on the mood of academy graduates. Some 80.41 percent of the respondents have a pessimistic assessment of their prospects, and only 18.92 percent are optimistic about the opportunities to continue their service. The problem of the drop in prestige of officer service in society also cannot pass unmentioned. The opinions of the graduates are quite well-founded, and reflect that picture (87.4 percent had a negative answer to the question of the prestige of the service).

A dilemma faces the graduates of military academies, and many officers in general—to continue to serve or to resign into the reserves?

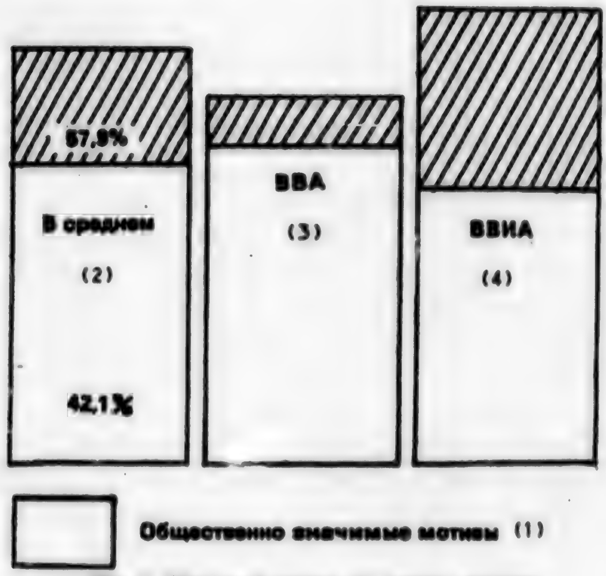

Fig. 2. Choice of values in service activity

Key:
1. socially significant motives
2. average
3. VVA
4. VVIA

Your attitude toward the alternatives—continue to serve or be discharged:	number of replies	percentage
I intend to be discharged in the near future	12	5.6
the desire to be discharged arises only once in a while	34	16.1
I would be discharged, but I am afraid of not finding work	14	6.5
I would be discharged, but I do not have enough time served for a pension	27	12.7
I will be discharged as soon as I obtain suitable housing	35	16.6
I do not yet intend to be discharged	81	38.8
I do not even permit myself to think about being discharged	6	2.8
other variations	2	0.9
TOTAL	211	100

The table shows the attitude of Air Forces academy officer graduates toward this problem. Just 2.8 percent expressed a firm desire to serve. Uncertainty in the responses was typical—54.9 percent of those polled had a difficult time giving a clear-cut answer, which is most likely explained by the lack of clear prospects and the situation in the country. The vividly pronounced readiness of most of the attendees to be discharged from the army cannot help but cause alarm. Many (35.8 percent) are being held back from that step only for reasons of a socio-economic nature—the lack of housing, not enough time served, the fear of not finding work. This fact cannot help but make one wonder about the qualitative composition of the future command personnel of the Air Forces. One can hardly hope that an officer who is inwardly ready for early discharge, and wishes for it, will perform the duties entrusted to him by the state and society in a creative manner and with good return.

The desire of graduates to be discharged into the reserves was verified during the questioning with the aid of a control poll. Data were obtained in that that make it possible to conclude that more than 40 percent of them do not wish to serve. The main reason determining the desire to be discharged is the lack of social protections and dissatisfaction with material status—38.8 of those polled. Another 33.6 percent explain their decision by the decline in prestige of military service, 11.21 percent by its lack of prospects, and 7.76 percent by negative phenomena in the army and society.

Study of the readiness of graduates of Air Forces academies for service has confirmed that one of the main components of this concept, complex in composition, is the military-professional thrust of the officer. It is expressed in the high significance of military affairs for him and the military specialty he has selected, as well as in the level and pattern of his official aspirations. All changes in this thrust most naturally have an effect on the state of professional readiness. The data cited make

it possible to conclude that a reduction in military-professional thrust is being observed in some of the graduates of Air Forces academies. The negative consequences of this process are obvious.

The principal contradictions, among those affecting the formulation of the professional readiness of the officer, are manifested between the constantly increasing demands on the officer corps and the not clearly expressed desire to conform to them; the need to protect the Fatherland and the low social status of the officer in society and lack of social protections; and, the desire to improve knowledge and skills and the presence of various types of regimentation.

Sociological analysis makes it possible to determine the areas of work that will be able to provide for the resolution of these discrepancies in the future, and to formulate some recommendations.

It seems expedient, then, to alter the system of selection both for all types of military-training institutions (including the military academies) and for assignment to positions. The principal criteria should become the level of military-professional thrust, the individual capabilities and features, the overall development of the intellect and the level of specialization attained. This would make it possible, with the scientifically substantiated organization of selection, to avoid subjectivism in the resolution of personnel issues and to eliminate protectionism. We do not yet have at our disposal reliable, comprehensive techniques that would make it possible to accomplish these tasks. But they do not exist only because they have not yet been in demand. The combined efforts of various specialists, with the corresponding social demand, will provide an opportunity to develop the necessary techniques in a relatively short time.

It would be expedient, on an organizational plane, to individualize the process of professional training for the officer, with the aim of making fuller use of individual capabilities, abilities and characteristics. The content of training should be as close as possible to the practices of military activity; this requires, on the one hand, an optimization of existing forms and methods of training and, on the other, substantial changes in the theoretical and practical training of instructors. A modern physical plant and the development of a system of incentives, along with changes in the methodological support for the teaching process, deserve particular attention.

The solution of the problems of social and legal protections for officers (and all servicemen!) and their provision with acceptable material conditions seems very important. If the state needs today's military professionals, it should provide full-fledged solutions to these problems. Otherwise, the outflow of more than the worst personnel from the army in the very near future will lead objectively to a clear reduction in the level of professional readiness of the officers, which could call into question not only the practice of military reform, but even the very idea of it.

It seems obvious that the comprehensive realization of the above recommendations is an essential condition of their utilization for the attainment of positive results. That is because incomplete work or omissions in any of the three areas noted will make it impossible to achieve the desired effectiveness in the training of cadres for the new Russian Army.

From the Editors. *The sociological research whose data have been employed by the author was conducted in the summer of 1992. The economic situation and the problems connected with it have scarcely become less acute since that time. Military reform, however, is proceeding. Thanks to the adoption of a series of legislation, and first and foremost the Law on the Status of Servicemen and the Law on Pension Support for Servicemen, the situation has obviously changed. We will acquaint the readers in coming features with how the mood of Air Forces cadres is changing in the course of military reform, and how the greater social and legal certainty of the status of the officer in society is affecting them.*

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Profiles of Su-25, A-10A Ground-Attack Aircraft

94UM0094G Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 5, May 93 (signed to press 6 Apr 93) pp 30-31

[Article by M. Levin under the rubric "Information for Reflection": "Ground-Attack Aircraft"]

[Text] *Ground-attack aircraft, which were developed most heavily in Soviet aviation during the Great Patriotic War, were removed from service in the 1950s. The work stopped at that time on the try-out of new aircraft in this class. The experience of local wars, however, forced a return to the idea of creating a specialized, well-armored aircraft armed with a powerful cannon for the battlefield. The Su-25 and the A-10A thus appeared almost simultaneously in the USSR and the United States.*

Su-25

Versions. Su-25 UB (1985)—combat trainer; SU-25UT (1988)—trainer intended for air clubs; SU-25UTG (1989)—carrier-based trainer.

Crew. One.

Dimensions. Wingspan of 14.36 meters, area of 30.1 m^2; length of aircraft (with PVD [pitot boom]) 15.36 meters, height 4.8 meters.

Mass (with R-195 TRDs [turbojet engines]). Maximum takeoff 17,600 kg, normal takeoff 14,600 kg.

Flight characteristics (with R-95Sh TRDs). Maximum speed at ground level 950 km/hr, landing speed 200 km/hr; maximum weapons delivery altitude 5,000 meters; effective flight range with ordnance load of 1,000 kg and without external fuel tanks at ground level 510 km, maximum ferry range with four external tanks more than 1,850 km; turning radius with 1,500 kg bombs at

altitude of 1,500 meters: 570 meters at speed of 460 km/hr, 680 meters at speed of 555 km/hr; takeoff run 600 meters on hard-surfaced runways, 1,200 meters on unimproved runways; landing runout on concrete runway 400 meters (600 meters without braking chute); maximum operational G-forces of 6.5 with ordnance load of 1,500 kg, 5.2 with load of 4,000 kg.

Engines. R-95Sh (2 x 4,100 kgf) turbojet engines, R-195 (2 x 4,500 kgf) on later models.

Armaments. Gravity bombs of 100 to 500 kg, small payload pods, 57 to 270 mm rockets, air-to-ground missiles with Kh-25 and Kh-29 laser or television homing systems, cluster bombs of various types, pods with cannons or two R-60M air-to-air missiles on ten pylons. Normal mass of armaments on external stores racks 1,000 kg, maximum of 4,000 kg. Built-in armaments are GSh-30 twin-barrel cannon (30mm, 250 rounds, rate of fire 3,000 rounds/minute).

Equipment. ASP-17BTs-8 firing and bomb sight, Klen-PS laser rangefinder/target designator, A-031 radio altimeter, DISS-7 Doppler speed and drift angle meter, passive means of infrared protection, K-36 ejection seat. The aircraft design employed a fully welded cockpit with titanium armor, a canopy with an armored front optical block, protected fuel tanks filled with porous materials, and control lines with enhanced damage resistance. Later versions of the aircraft have the TRDs separated by an armored partition, and the firefighting system was improved using freon. An autonomous system of technical maintenance located in four pods that are transported on the external pylons of the Su-25 aircraft was developed for the aircraft, providing for the servicing of the aircraft at unimproved frontal airfields.

The SU-25 with the R-195 engine may be used as a target tow and platform for diving targets.

Status. In service with the air forces of the CIS countries, the Czech Republic, Slovakia and Iraq.

Additional Information.

The necessity arose at the end of the 1960s of creating a ground-attack aircraft able to wage battle successfully against small targets on the battlefield and at the front line, as well as for use in local conflicts. Attempts were undertaken to make such an aircraft on the basis of the Il-28 bomber, as well as to "resuscitate" the Il-40 project of the 1950s. Under these conditions, the OKB [Experimental Design Bureau] of P. Sukhoy proposed at the end of the 1960s, on its own initiative, the creation of a light and highly maneuverable armored ground-attack aircraft that would be fitted with existing armaments and equipment. Despite the fact that the idea did not meet with the unanimous support of the Air Forces (the pilots wanted to get an aircraft with advanced armaments and BREO [on-board electronics gear] optimized for use in ground-attack aviation), the program obtained approval from the leadership of the Air Forces. The first flight of the experimental T-8-1 aircraft fitted with the R-9 TRD (a variation of a non-afterburning engine that had been installed in the MiG-19), took place in 1975, after which the T-8-1 and T-8-2 experimental aircraft were fitted with R-95 TRDs created on the basis of the R-13 TRDF [afterburning turbojet engine]. Preparations for series production of the new aircraft began in 1976 at the aviation plant in the city of Tbilisi, and the first flight took place in 1978.

Twenty three aircraft were lost during combat operations in Afghanistan, with the death of eight pilots. One aircraft that was shot down had accumulated 2,800 hours of combat flying time. The Su-25 as a whole proved to be a most effective strike aircraft in Afghanistan.

The Su-25 earned the highest evaluation in the Iraqi Air Forces during the Iran-Iraq War.

Iraqi Su-25s were effectively not employed in combat operations in the Persian Gulf, but two aircraft were shot down by American fighters while attempting to fly to Iranian territory.

The improved Su-25T, which is deserving of a separate article, was created on the basis of the Su-25.

Fairchild-Republic A-10A Thunderbolt II

Versions. A-10B—a two-seat trainer, N/AW-10 (1979)—a version of the A-10B for operations at night and in bad weather conditions, OA-10D—forward air spotting and target-designation aircraft (retrofitted from series-production A-10A aircraft).

Crew. One.

Dimensions. Wingspan of 17.53 meters, area of 47.01 m^2; length of aircraft 16.26 meters, height 4.47 meters.

Mass. Maximum takeoff 23,680 kg, in takeoff from unimproved airfields 14,865 kg, without ordnance 11,320 kg; fuel in internal tanks 4,853 kg, in external tanks 5,300 kg (3 x 2,270 liters).

Flight characteristics. Top speed of 722 km/hr, speed at 1,500 meters with six 227-kg bombs 704 km/hr; cruising speed 623 km/hr at altitude of 1,500 meters; radius of operations when performing tasks of close support (including loitering for 1.7 hours) 460 km,, with deep strikes into enemy rear 1,000 km, ferry range of 3,950 km; takeoff run 760 meters, landing runout (with braking parachute) 410 meters.

Engines. General Electric **TF34-GE-100 TRDDs** [afterburning turbojet engines] (2 x 4,100 kgf).

Armaments. **GAU-8A** Avenger cannon (30 mm, 1,174 rounds, rate of fire 2,100/4,200 rounds/minute), up to 28 Mk.82 bombs (227 kg), up to six Mk.84 bombs (904 kg), up to eight BLU-1 or BLU-27/B **ZABs** [incendiary bombs], up to 20 Rockeye RBKs [combat missile systems], up to 18 **GBU-12** KABs [cluster bombs] (with laser homing systems) or **GBU-10** KABs, up to six **AGM-65A/B/D** Maverick guided missiles, two **AIM-9L** Sidewinder missiles, two **SUU-23** (20 mm) external cannon pods. The number of weapons racks is eleven, with a maximum load of 7,260 kg.

Equipment. The Tacan radionavigational system, the **ASN-141** INS [inertial navigation system], an instrument landing system, ILS [head-up display], ELT [television radar display] indicator providing the opportunity to employ the Maverick missiles with television or infrared homing systems; the **AN/AAS-38** Pave Penny laser target search and tracking laser system in a pod under the fuselage in the nose (there is no laser rangefinder/target designator; the aircraft is able to operate against targets illuminated by laser from another aircraft or the ground), an **AN/ALR-46(V), AN/ALR-64 or AN/ALR-69** radar illumination warning receiver, an **AN/ALE-37** or **AN/ALE-40** chaff and IR decoy dispenser, and an **AN/ALQ-119** pod with jamming transmitters (on external racks).

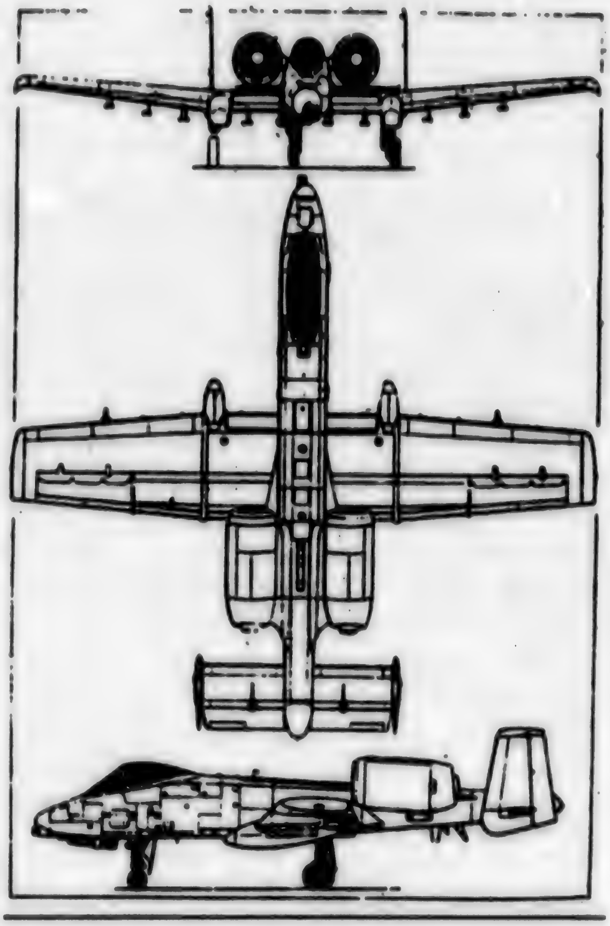
The installation of a system to warn of proximity to the ground is also possible. Armoring protects the cockpit and other vitally important parts of the aircraft against shells up to 23 mm in caliber (the mass of the cockpit armor box is 544 kg).

The ejection seat is a McDonnell-Douglas **ACES-II**.

There is an aerial refueling system as well.

Status. Series produced from 1975 to 1984. There were 813 aircraft built. There were 610 A-10A/B and 20 OA-10D aircraft in service with the Air Force and the National Guard of the United States in 1992. The aircraft costs 7.3 million dollars (at 1980 rates). It was not supplied for export.

Additional information. Generation of TTT [tactical-performance specifications] in 1966, issue of contracts for development in 1970, first flight of experimental aircraft in 1975. The experimental two-seat **N/A-10W** version, refitted from the A-10B trainer and intended for operations at night and in bad weather conditions, was tested in 1979. Testing of aircraft equipped with **AIM-9** Sidewinder missiles, intended for self-defense, was conducted in 1986. The possibility of replacing these aircraft with A-16 strike aircraft using the General Dynamics **F-16C** fighter has been under study in the United States since the end of the 1980s (an aircraft of this type was to have performed the tasks of close support and battlefield air interdiction, *i.e.* combine the functions of a ground-attack aircraft and a fighter/bomber), owing to the ineffectiveness of the A-10 in operations against the second echelon of enemy subunits. Funds were not allocated for the program, however, because of the cutbacks in defense spending.



The high survivability of the aircraft made it possible to retrofit some of the ground-attack aircraft into forward air spotter aircraft (they are replacing the North American **OV-10** Bronco aircraft, which had been used as far back as in Vietnam, in this role).

The A-10A showed itself to be one of the most effective means of defeating manpower and vehicles on the battlefield during the combat operations in the Persian Gulf. The aircraft were employed both day and night (with the aiming performed using the infrared homing heads of the Maverick missiles). The combat losses were

five A-10A aircraft. Fire from the cannon of an A-10A attack aircraft shot down an Iraqi Mi-8 helicopter.

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Sloppy Preparations Undermine 1990 MiG-29 Ferry Flight to Iran

94UM0094H Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 5, May 93 (signed to press 6 Apr 93) p 32

[Article by Lieutenant-Colonel B. Kononenko under the rubric "There Was Such a Case": "SOS in the Iranian Sky"]

[Text] *Was our country selling weapons in the world market? The answer is unequivocal—yes, we were selling weapons and combat hardware. The only thing that cannot be understood is, why hide it from our own people? Quite a few articles have been published on this score in the open—but foreign (!)—press, citing figures that testify eloquently that the trade was profitable for us. And not only in a financial regard, but first and foremost in a political one as well. There, as they say, we were at the top.*

An entirely concrete instance compelled me to take up the once-forbidden topic. I found out about it in a fighter air regiment armed with MiG-29 aircraft. I was interested, in a conversation with an engineer of the regiment, how matters stood with the delivery of spare parts and units to the technical maintenance unit [TECh]. In reply he only spread his arms—a total back-up, he said. It turned out that the "back-up" dictated its own rules. Some equipment in good working order was removed from an interceptor that had just come into the TECh and installed on an aircraft on which the regular maintenance work was almost completed. The newly arrived fighter was expected to be "stuffed" with parts from another one waiting for preventive repair. And so it goes around and around from month to month.

"We are selling MiGs abroad and sending the spare parts there, and we are left with nothing," summed up an officer in a fit of temper.

It was not all that hard to find out that some pilots in the regiment have already flown to Iran several times, ferrying MiG-29s procured by that country to them. The fliers, true, got no pleasure from these overseas trips—there were too many of all sorts of conventions in making the ferry flights. The notorious "just-in-case" was in effect here as well. Everything was heading toward something bad happening. And it did not take long.

The latest pair of fighters, piloted by deputy squadron commander Major A. Yermakov and senior pilot Captain S. Nikulin, headed off for Teheran at the end of September 1990. The pilots crossed the border of the USSR at a location coordinated in advance at the stipulated time. They then took a heading of 120°. It became clear that an instrument in the wingman's cockpit was steadily reading thirty degrees more than the lead pilot's. The latter unfortunately neglected the report of his subordinate on this, assured of his own infallibility. And when he finally thought about it, it was too late to make corrections.

The nominal flight time had expired. Teheran should have shown up below, with the airfield a little further. But...

Flight operations officer Major A. Berzan, who had arrived at the Mehrabat air base earlier to meet his countrymen, looked up at the sky in vain, listening for the characteristic drone of the fighters. He, after all, while controlling the fighters from the ground, had been left "blind"—radar monitoring of the air traffic in the area of the landing airfield was not being conducted for the pair of Soviet MiGs. The situation was clarified by a report over the air by the lead aircraft regarding a loss of orientation. Yermakov did not conceal the fact that his last hope in the prevailing situation was an escort aircraft, using which the possibility remained of reaching the end point of the route. The commander of the Iranian air base, however, did not fulfill his promise to help, and an F-5 that was in reserve for such a situation did not go up.

The pair of MiG-29s loitered for forty minutes over Iranian territory. Nikulin suddenly lost sight of the lead aircraft on one of their turns, after which he independently made the decision to look for the nearest airfield. The wingman was lucky. The captain unexpectedly saw a runway right on his heading and landed safely—now with almost no fuel in the tanks—at the Savi airfield. "I was born lucky," he commented laconically at the time on his good fortune.

But Yermakov, who had waited unsuccessfully for a guide aircraft, tried to land on a highway, but was hindered by the heavy vehicle traffic. Seeing the hopelessness of the situation, he ejected after an hour and fifty minutes of flying. "There was no damage on the ground. The pilot was unharmed," were the notations in the report.

Maybe so, but we know how to give a good spanking. So they exhaustively investigated the sad results of a generally ordinary flight, and the measures taken, judging by the official documents, were the strictest. Major Yermakov was relieved of his duties and dismissed from flight work, and the "lucky" Nikulin was disciplined as well. All's well that ends well. Nonetheless, in my opinion, the materials from the investigation did not reflect the main causes that led to the flight accident. One of them was the unsatisfactory preparation and support of the ferry flight. The regimental command did not know the concrete date of the ferry flight to fill out the necessary documents until the very day of departure of the pilots for Moscow. The fliers (called back the day before from leave, by the way) were given just seven days instead of the required 20 to prepare for the performance of this task. Communications specialists had appealed

more than once to higher-ups on the question of providing reliable radar control of the aircraft being transferred, but that was not resolved either. It turned out that the organizers of the flight had simply not stipulated in the agreement the necessity for the receiving side to turn on its tracking stations, or the amount of payment for their operation either... They economized themselves into disaster.

And here is a fact that is quite interesting, although it was not taken into account in the final order. Captain Nikulin made a forced landing at the airfield at Savi, which was not even indicated on his flight map, and indeed could not have been, since it was published in 1966, with some changes on it dated 1981. It is incomprehensible why satellites are plying outer space—perhaps to photograph the license plates of cars...

Yes, the times are such that we have to economize in everything. But in this case they cannot bring themselves to call this economy squandering by the true steward. Is that not why the pilots are so reluctant to agree to the commercial ferry flights for which the Russian state pays them in dollars? Not everything is for sale...

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Baykonur Support Troops Commander Recalls Highlights of Service

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[Article by Candidate of Technical Sciences Major-General V. Menshikov under the rubric "The Cosmodromes: Rockets and People": "Rocket Test Personnel"]

[Text]

The Unskilled Workers of Space Science

The test and operational personnel at the cosmodrome were called the "the unskilled workers of the Earth." A song written by local composers even has the words, "The unskilled workers of the Earth are launching ships into space..."

But far from everyone knows that Baykonur also has "unskilled workers' unskilled workers." People dear to my heart and soul—the officers, warrant officers, sergeants and soldiers of the units for combat support and maintenance. They include repair and reconditioning, railroad, power and water battalions, subunits for the heat and power systems, oxygen and nitrogen, bread-baking and many others. They are to the cosmodrome as air is to people—you don't notice it as long as you are breathing, but cut it off and you suffocate at once.

Everything "hangs" on these battalions—the launches of the rockets, the well-being of the test personnel and their families, the normal life of the city of Leninsk, the launch pads—you can't list them all. The main incentive for their personnel is not to get chewed out by their superior officers.

Imagine Baykonur in the forty-degree heat without water. It is not for nothing that they say in the water battalion that they pump the blood through the arteries of the cosmodrome. And there is no exaggeration there. It is in fact the life's blood of Baykonur.

The sergeants and soldiers have recently been receiving, for these heavy labors, pay that is 200—300 times less than that of their civilian colleagues.

But weather and climatic calamities remain the most terrible of all for the support battalions.

July of 1988. The winds around the main substation of the cosmodrome seemed enough to blow all of Kazakhstan away. The wind speeds were more than forty meters a second, lightning was flashing constantly, the peals of thunder were rocking the broad expanse of the steppe. The hurricane winds, in a wild dance, even bent, twisted, broke off and twisted into a "ram's horn" the huge and strong towers for the electric-power lines as if they were made of nothing. The roofs of substation buildings were torn off, and windows and doors were knocked out. Powerful concrete towers were toppled like matches. I and German Stepanovich Titov, at the time the first deputy chief of the space units, got through with difficulty to the stricken substation so as to check out the situation at the scene. There was so much rain water that it poured over the door sills of the Volga and flooded the passenger compartment. It felt like the car was floating rather than driving down the concrete road. This was in the desert! No one would believe it.

The cosmodrome and city of Leninsk were left without electricity and water. In the disaster area they scraped up some vehicles and brought in the power battalion of Major S. Fedorenko. The battle with the natural disaster lasted almost the entire day. The first two towers were restored, and the city received a partial supply of water and light. Power was supplied to all the facilities on the cosmodrome after five continuous days of hellish labors. They slept for four or five hours right at the work sites, because they understood that a cosmodrome without power was a dead cosmodrome. Captain O. Godlevskiy and Senior Warrant Officer P. Gonzilovskiy stayed up in the rebuilt towers of the power lines for 18 hours a day, installing insulator strings passed to them on the LEP-220 towers.

Who can say whether this was heroism or not? For me, it unequivocally was. And thankfully no one cursed the power workers.

A January night in 1991. I awake from a heart-rending wail—the safety valves had been triggered at the city's TETs [heat and electric-power plant], which was also serviced by the military. I grab one telephone—silence; a second—the same. Everything became clear—the TETs

was "at zero." I looked at my watch—just after three. I open the hot-water tap—empty; the cold—not a drop.

And now I understood that the whole power system of the cosmodrome, and not only the TETs, was out of service. Outside, thank God, it was only minus five degrees. Thinking quickly, I saw that if power could not be fed to the pumps in 18 hours, we would have to pour out the water, in the most direct sense. I got the creeps—God forbid.

I ran to the TETs with the other officers. The cause of the accident was ascertained—a rupture in a pipe 1,200 mm in diameter near the 35-kV substation. The substation was flooded, the TETs was not operating and it was impossible to hook into the outside grid of the power system. And that meant that all of the boilers at the cosmodrome would stop in an hour, since there would be no water.

The city and the cosmodrome were sleeping and dreaming. The "unskilled workers" of the battalion, the hard-working battalions, the invisible great laborers, went into action. It was they who started up the diesels, put the flooded substation back into shape, turned on the boilers and turbines. Behind every pump, boiler, valve or switch there was a soldier or officer. It was they who "warmed" the sleeping citizenry. But by two o'clock in the afternoon they had already been forgotten, since the city was receiving water and light. A few knew that people were then working for another seven days straight so as to make everything right.

And what a nightmare frequently begins for the support battalions in the summer, when 15—20 cables suddenly burst into flames simultaneously owing to the two- or three-fold overloading in the forty-degree heat (in the shade), leaving 150—200 homes and service buildings without electric power. Phone calls, insults, blow-ups by superiors, complaints from residents...

But as soon as the electric power is restored through three or four days of continuous labor by soldiers and officers under the searing sun, everything settles down again. And no one cares that the cables have been lying in ground permeated by salt for 35 years, when the standard is ten, and that is under normal operating conditions. It is also not taken into account that the demands on the power system are two or three times the maximum possible according to the design (the city and the cosmodrome, after all, have grown to 100,000 people). How much grief and misfortune has been caused people by this rotted-through equipment built at some time under the "whatever's-left-over" principle?

Tragedy at the KAZ

The end of December 1985—a year of great catastrophes. They affected the Baykonur cosmodrome as well. Two days before the new year, at the end of the day, the chief engineer of the oxygen-nitrogen plant [KAZ], A. Kozharov, reported that "there has been an explosion at the KAZ, someone has been killed, we are investigating."

I went immediately to the plant. I heard the rest of the report: "There was an explosion during the welding of a barrier in the shop. One soldier has been killed, and about thirty have been injured." I went into the shop, or more precisely what was left of it. There was enormous hole about thirty meters in diameter where the ceiling used to be. Chaos, a heap of mutilated structural elements. A terrible picture, I had never seen anything like it. Among the debris were the shattered remains of the soldier, who had been thrown by the wave of the explosion into the concrete ceiling, where a bloody spot was visible. I had never seen a human death in such a naked form. I felt queasy and left the shop quickly. The injured—27 officers, sergeants and soldiers—were already being taken off to the hospital by medical vehicles. That was the price of the explosion. A cruel price.

I began to look into the causes. It turned out that Oxyliquit—a mixture of oxygen with organic substances—had exploded. Long ago, back during the construction of the plant, the wooden framing had been left in the shop out of either haste or neglect. It had become a delayed-action bomb in the direct sense of the word. An oxygen drainage pipe ran over that framing, and it had seeped through the concrete into the wooden boards. This meant that a "bomb" had been erected. The sparks from the welding were enough for the tragedy to occur. The shop had been in operation for about 30 years—three times longer than planned. It had been proposed to be closed and written off many times. But it was producing its five tonnes of oxygen a day, and somebody higher up liked that; the documents for closing the shop were invariably returned to the cosmodrome. I would like to look the construction inspector in the eye who had "not noticed" the framing left in the concrete floor. After all, he knew full well, the bastard, that this was categorically forbidden, that is why he was assigned there, after all.

The Cognac of the Construction Workers

I would like to say, for the sake of objectivity, that the greater portion of the blame for such tragedies should be assumed by the test personnel of the cosmodrome who took part in the servicing of various systems and equipment. Once I was included on a commission to accept a "Greek hall"—accommodations for American astronauts and guests—from the military construction personnel. The basic work had already been completed, only little things remained—a week of work and it could be turned over ready to go. But they wanted to turn it over a little sooner, and "brighten up" the bonus. The system for turning over facilities by construction workers is not a new one, but someone, to put it bluntly, was acting with a great deal of inventiveness. They made particular use of the "current moment of profound love and devotion to their dear party and the wise Politburo, headed by the latest true Leninist."

The commission gathered at one of its last sessions—matters were moving toward completion. We went into the "Greek hall" for the next session, and there were

tables so covered you couldn't believe it. The members of the commission objected weakly—it's not time yet, we have to finish our work. Nothing of the kind! The chief of the UNR [office of the work supervisor] promptly poured cognac into the glasses and, ignoring the objections of the commission members, gave a rousing toast: "To our dear party and our dear Soviet government!"

Try not to drink and they would stick you where they had to—you would end up a dissident. The next toast—"To the General Secretary," then "To the unity of the army and the people," and then any document was signed without reservation. Since many members of the working commission were also on the State Commission, matters were considered closed—the "Greek hall" was accepted. Welcome, American astronauts.

How Good It Is to Be a General

Time passed, and I progressed in the service, got a little older and wiser and got used to cosmodrome service, life and living. It was only impossible to get used to the heat or the cold. It got easier to endure, true, as I advanced along the service ladder. First I lived in a "pencil-box"—a twelve-meter room in a two-room apartment. Then one-, two- and three-room apartments. Seventeen years on the top—fifth—floor. The greatest torments were in the summer months. Many of the test personnel sent their families off to "the great land" during that time.

The main problem during those times was to somehow get some sleep after a difficult work day. It was hellishly stuffy in the apartment. Everything was hot, even the doorknobs and dishes, nothing was cool enough. There was one way out—cover up with a wet sheet and try to sleep until it dried out. It got cooler toward the middle of the night. We went quickly to the balcony, on a folding bed. Even though the mosquitoes were a problem, they were tolerable, you could fall asleep by three at night. "And in the morning, the gasoline locomotive again," as they sing in the well-known Baykonur song.

The locomotive! The great cosmodrome "hoe" in which the test personnel spent 10—20 percent of their lives while they were serving at Baykonur. The cars of the locomotives in the 1960s were very clean and very hot. It became cool and dirty in the modern cars with air conditioning. That is how scientific and technical progress and the decline in the cultural level and cultivation of the test personnel was reflected in the hard-working gasoline locomotive. What were the test personnel doing in the locomotives? Reading, playing chess and cards, sleeping. And arguing, arguing, arguing. About space and about their own difficult life, the fate of the military before and after pensions, universal problems and... the best recipe for diluting alcohol. And, of course, about women. And what locomotive folklore of the test personnel there was! Where are you, poets and writers? There are very rich, untapped strata for your righteous labors here. Take a look, take a ride there and back. You will hear more than you could write in a lifetime.

I was hugely lucky in my last three years of service at the cosmodrome—I lived, in accordance with my official position, in the "wooden town" built at one time for the supervisors of the cosmodrome. What can I say? It is correct what they say in the song, of course: "How good it is to be a general..." An excellent cottage, a garden in the yard, fruit trees and grapes. The temperature in the rooms was four or five degrees lower than in the brick houses.

And one wonders what kept them from building such housing then, at the very beginning, for all of the test personnel, and not just for the supervisors. Relaxing in the yard under the grapes for even just an hour in the evening gives you quite a different attitude toward the service, a different look at cosmodrome life. But most of the officers and soldiers still have to test themselves along with the rockets under the constant blows of the harsh climate of the Kazakh steppes, to which a Russian person is unaccustomed.

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SLBM Conversion For Civilian Launches Continues

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[Article by Machine Building KB [Design Bureau] imeni Academician V.P. Makeyev General Designer Igor Ivanovich Velichko under the rubric "Conversion of the Sector": "Swords Into Plowshares"]

[Text] *An enormous quantity of weapons has been accumulated around the world. But detente has come, and a considerable portion of them have become unnecessary and subject to cutbacks; this includes ballistic missiles of various classes. Many types of them use highly toxic fuel components that we are not able to turn into harmless substances in large quantities. They could destroyed through burning in rocket engines attached to special installations, for example. But the harmful emissions and impurities would remain in the lower Earth atmosphere thereby. They could also be launched without warheads. It is difficult to monitor this process, it is true, and the problem of the falling stages also arises—consequently, with the same harmfulness. But one could also use these terrible weapons for peaceful purposes. Igor Ivanovich Velichko, general designer of the Machine Building KB [Design Bureau] imeni Academician V.P. Makeyev, talks about that.*

Our KB is the lead developer of ballistic missiles for submarines. The collective has created all of the SLBMs [submarine-launched ballistic missiles] that are in service with the Navy today. But the times are changing,

and we have begun the creation of research and commercial rocket and space systems for the conversion of our activity. The wealth of scientific, technological and production potential of the developers and manufacturers of the SLBMs, as well as the program of utilizing the missiles after their retrofitting into research and commercial launch vehicles for spacecraft, serves as the basis for that.

We are proceeding in several directions in cooperation with Russian enterprises and organizations, first and foremost on the path of the immediate utilization of all existing missiles for peaceful purposes—launches of the retrofitted missiles from the silos of operational submarines in conjunction with the Russian Navy. This is entirely realistic, because in accordance with the Treaty on the Reduction of Strategic Offensive Weapons and the agreement to develop it that was signed in 1992 by the presidents of the Russian Federation and the United States in Washington, a considerable quantity of missiles will be freed up. The modified RSM-25 (SS-N-6) in particular, which has received the name Zyb, launches recoverable craft on close to a vertical ballistic trajectory with a microgravitation level of 10^{-4} g and a duration of weightlessness of 17 minutes. Zyb missiles are launched from submarines on the battlefields of the Northern (area of the city of Arkhangelsk) and Eastern (area of Kamchatka) test ranges, equipped with measuring instruments, search systems and for the prompt delivery of the descent craft that have landed.

It is namely the microgravitation that makes it possible to realize new technologies. Our KB, in conjunction with the Kompozit NPO [Scientific-Production Association] and the Center for Space Biotechnology, has developed two types of craft:

—a technological module weighing 450 kg, with an installation accommodated in it for trying out processes to obtain semiconductor materials with improved crystalline structures, superconducting alloys and other materials;

—a biotechnological module weighing 650 kg, to try out technologies for cleaning biological compounds and the commercial manufacture of especially pure biological and medicinal compounds using the method of electrophoresis.

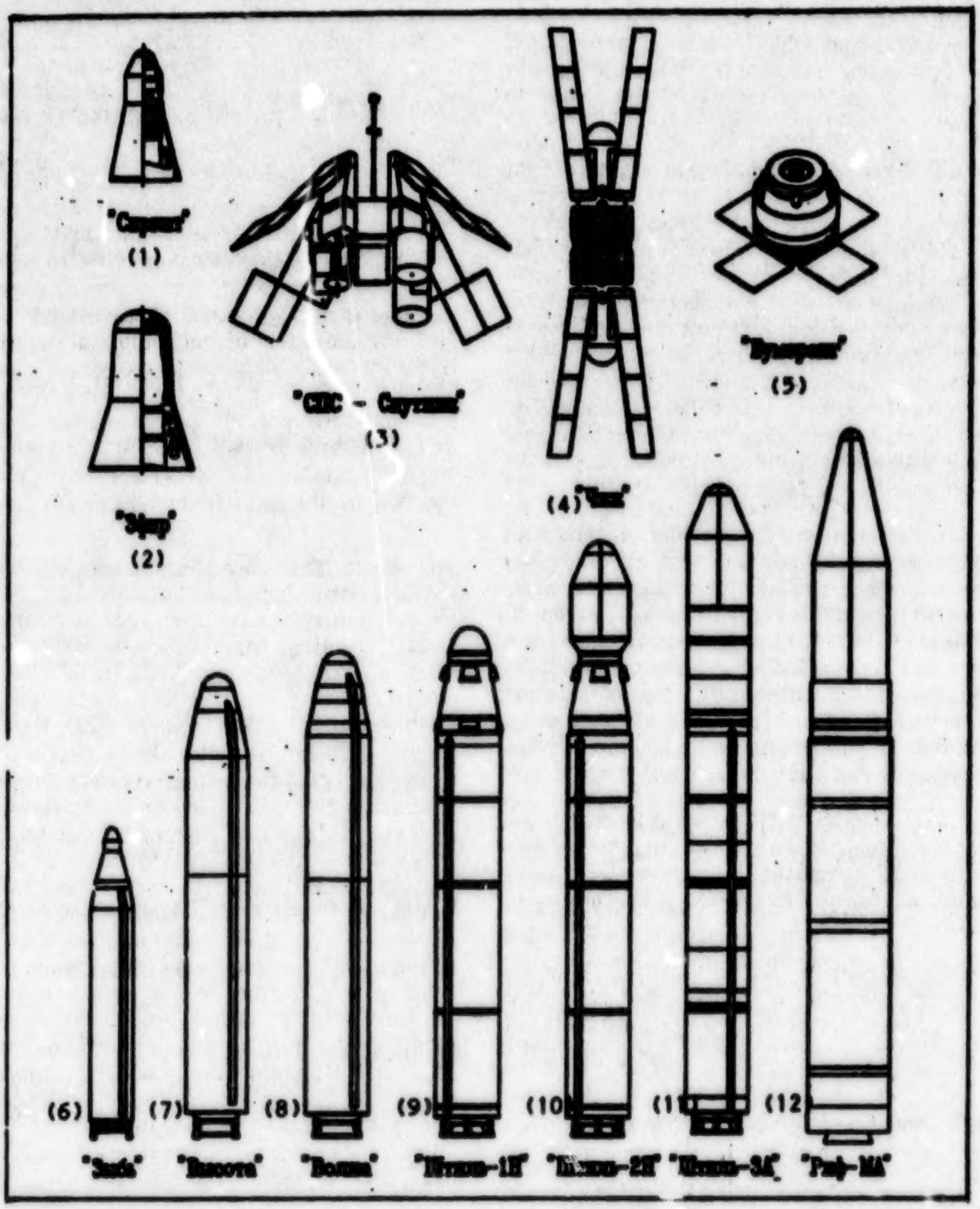
We conducted the first experimental launch of the Zyb missile at the end of 1991 at the Northern Test Range of the Navy, with a technological module fitted with 15 ovens containing quartz ampules with various sets of initial materials. The chain of preparation, launch and recovery of the module was checked out, with the necessary functional conditions for the special technological equipment ensured. We now have the first materials that were manufactured under the conditions of the flight of a submarine-launched ballistic missile.

One of the samples is a silicon crystal with a high level of germanium doping, grown at a speed of 10 mm/minute—that is, an order of magnitude greater than under Earth conditions. Quick analysis showed that these are defect-free monocrystals, 10—30 mm in length and on the order of 12 mm in diameter, with a homogeneous distribution of impurities. Samples of metals and alloys with new properties were also obtained.

The regular operations of the Zyb missiles in the interests of space technologies should begin in the middle of this year. Retrofitted RSM-40 Vysota (SS-N-8) and RSM-50 Volna (SS-N-18) missiles could be used for their launch from submarines, where necessary, to increase the time the modules are under weightless conditions to 30 minutes and the amount of technological equipment. The Bumerang and Chizh orbital recoverable craft created at our KB will be used in the future. They will be placed into orbit by more powerful missile systems, and will have a period of active existence of up to several dozen days. The Russian Space Agency (RKA) is financing and supporting the work on the space technologies.

The thrust of the work is the creation of the refitted Shtil-1 missile based on the RSM-54 (SS-N-23) series-produced missile, a commercial system for the launch of "small" satellites from our ground launch complex near the city of Arkhangelsk, which used to be used for testing combat missiles. The mass of a payload placed into orbit by this missile, with an inclination of 70° and an altitude of 500—700 km, is 250—300 kg, with a volume of 1.5 m^3. The deployment of a system of personal satellite communications, intended for the transmission of text, digital and facsimile messages using the principle of "subscriber—spacecraft—subscriber" or the method of "electronic mail," is being placed using the Shtil launch vehicle in 1994-95. The Uralkosmos joint-stock company, formed by a group of industrial enterprises in the defense complex, banks and organizations of potential customers, is engaged in the realization of this project. Launches of the Shtil-3N launch vehicle, which is a variation of a more profound modification of the series-produced RSM-54 (the warhead compartment and engine for the separation of the warheads have been replaced with a more spacious payload compartment and new orbital-insertion engines), could be made from the ground launch complex starting in 1995.

We consider the key element to be the development of a rocket system—the Aerokosmos project—that is accommodated on the An-124 and Il-76 aircraft. This system will make possible the efficient launch of satellites from any point in the airspace. The RSM-54 submarine-launched ballistic missile has been refitted as a commercial launch vehicle for air launching. A great deal of scientific research and experimental work has been done so far, and this project is moving into the stage of development of the working documentation. We feel that our KB is very ready for the implementation of this plan. The Aerokosmos joint-stock company has been formed for its realization (in 1995 and the start of commercial operation in 1996), and agreement has been reached for its support on the part of the RKA.



Key:
1. Sprint
2. Efir
3. SPS-Sputnik
4. Chizh
5. Bumerang
6. Zyb
7. Vysota
8. Volna
9. Shtil-1N
10. Shtil-2N
11. Shtil-3A
12. Rif-MA

The technical essence of the project is as follows. The missile is accommodated inside a transport aircraft on a launch platform in a horizontal position, and is ejected using a parachute system, after which it separates from the platform with the simultaneous ignition of the engines. The missile can hold a satellite up to 1,000 kg in mass in a volume of 3.5 m^3 (dimensions of 1.6 meters in diameter and 2.3 meters in length). The mass of a satellite is 500 kg when placed in a polar orbit of 700 km in altitude.

The retrofitting of the RSM-52 (SS-N-20) missiles will be completed in 1997, and will make it possible to put payloads of 1,000 kg into polar orbits 800 km in altitude in a compartment volume of 4 m^3 with launch from an An-124 aircraft.

All of the modified SLBMs described are in the class of light launch vehicles, and serve for the launch of light payloads (up to one tonne) into space or the upper layers of the atmosphere. Research into the market for payloads has indeed shown substantial growth in the need for small spacecraft, including low-orbit communications satellites and spacecraft for the system of global ecological safety, among others. There could be a need for about 300 such satellites before the year 2000. It would hardly be expedient for them to be launched several at a time by one heavier rocket or shuttle craft, due to their lower efficiency, higher cost and lesser accessibility to many countries that do not have their own missile and space technology.

Our program, which envisages the attraction of funds from domestic commercial structures and foreign investors, has been approved by the government of the Russian Federation. A decree on this question was signed by President B. Yeltsin in June of 1992. It must be said that we have a vested interest in attracting foreign partners, on a mutually advantageous basis, due to the difficulties in financing large-scale elements of the program using Russian domestic sources. The restrictions on the launch of foreign satellites in which American high technology is used by Russian launch vehicles must be removed as soon as possible for successful international collaboration in the realm of space research. Moreover, even though the fundamental opportunities for the use of strategic launch vehicles are inherent in the START Treaty, they must be expanded. Third countries in particular must be granted the right to conclude agreements for the use of such retrofitted Russian or American missiles. The Russian Federation and United States must be permitted to launch satellites for civilian purposes from mothballed military launch positions—submarines, ships, aircraft and from land. The restrictions on the quantity of retrofitted missiles and their launches would best be removed.

Things should be done to see that the strategic defensive potential being freed up begins to work in the interests of the world community.

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